

IN THE CLAIMS:

Kindly replace the claims of record with the following full set of claims.

1. (Currently amended) A method of calculating iteration values for free parameters

$\lambda_{\alpha}^{\text{ortho}(n)}$ of a maximum-entropy speech model MESM in a speech recognition system with the aid of the generalized iterative scaling training algorithm in accordance with the following formula, the method comprising the step of

iteratively determining:

$$\lambda_{\alpha}^{\text{ortho}(n+1)} = G(\lambda_{\alpha}^{\text{ortho}(n)}, m_{\alpha}^{\text{ortho}}, \dots)$$

where:

n : is an iteration parameter;

G: is a mathematical function;

α : is an attribute in the MESM; and

$m_{\alpha}^{\text{ortho}}$: is a desired orthogonalized boundary value in the

MESM for the attribute α ,

characterized in that the desired orthogonalized boundary value $m_{\alpha}^{\text{ortho}}$ is calculated by linearly combining the desired boundary value m_{α} with desired boundary values m_{β} of attributes β that have a larger range than the attribute α .

2. (Currently amended) A method as claimed in claim 1, characterized in that the

calculation of the desired orthogonalized boundary value $m_{\alpha}^{\text{ortho}}$ for the attribute $\alpha=\beta_0$ comprises the following steps:

- a) Selecting all the attributes β_i with $i=1\dots g$ in the speech model that have a larger range RW than the attribute $\alpha=\beta_0$ and include the latter;
- b) Calculating desired boundary values $m_{\beta i}$ for the attributes β_i with $i=0\dots g$;
- c) Sorting the attributes β_i with $i=0\dots g$ according to their RW;
- d) Selecting one of the attributes β_i having the largest RW;

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- e) Checking whether there are other attributes β_k which include the attribute β_i and have a larger RW than the selected attribute β_i ;
- f1) If so, defining a parameter X as a linear combination of the orthogonalized boundary values $m_{\beta_k}^{ortho}$ calculated in step g) during the last run of the steps e) to g) for all the attributes β_k that have a larger range and are determined in the most recently run step e);
- f2) If not, defining the parameters X to X = 0;
- g) Calculating the desired orthogonalized boundary value $m_{\beta_i}^{ortho}$ for the attribute β_i by arithmetically combining the desired boundary value m_{β_i} with a parameter X; and
- h) Repeating the steps e) to g) for the attribute β_{i-1} whose RW is smaller than or equal to the RW of the attribute $[[\beta_i]] \beta_i$ until the desired orthogonalized boundary value $m_{\beta_0}^{ortho} = m_{\beta_i}^{ortho}$ with i=0 has been calculated in step g).

3. (Original) A method as claimed in claim 2, characterized in that the calculation of the parameter X in step f1) is made according to the following formula:

$$X = \sum_k m_{\beta_k}^{ortho}$$

4. (Original) A method as claimed in claim 3, characterized in that the calculation of the desired orthogonalized boundary value $m_{\beta_i}^{ortho}$ is made in step g) according to the following formula:

$$m_{\beta_i}^{ortho} = m_{\beta_i} - X$$

5. (Currently amended) A method as claimed in claim 2, characterized in that the calculation of the desired boundary values m_{β_i} for the attributes β_i with $i = 0, \dots, g$ is made in step b) by respectively calculating the frequency $N([[\beta_i]] \beta_i)$, with which the attribute β_i occurs in a training corpus and by subsequently smoothing the calculated frequency value $N(\beta_i)$.

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6. (Currently amended) A method as claimed in claim 5, characterized in that the calculation of the frequency $N([[\beta_i]] \underline{\beta_i})$ is made by applying a binary attribute function $[[f\beta_i]] f\beta_i$ to the training corpus where $[[f\beta_i]] f\beta_i$ is defined as:

$$f_{\beta_i}(h, w) f_{\beta_i}(h, w) = \begin{cases} 1 & \text{if } \beta_i \text{ fits in the word sequence (h, w)} \\ & \text{otherwise 0} \end{cases}$$

and where $f_{\beta_i}(h, w)$ indicates whether the attribute β_i correctly describes a pattern predefined by the word sequence (h,w).

7. (Currently amended) A method as claimed in claim 1, characterized in that the mathematical function G has as a further variable the magnitude of a convergence step

t_{α}^{ortho} with:

$$t_{\alpha}^{ortho} = 1/M^{ortho}$$

where

$[[Mortho]] M^{ortho}$: represents for binary functions f_{α}^{ortho} the maximum number of functions which yield the value 1 for the same argument (h,w).

8. (Original) A method as claimed in claim 7, characterized in that the attribute function f_{α}^{ortho} is calculated by linearly combining an attribute function f_{α} with orthogonalized attribute functions f_{β}^{ortho} is calculated from attributes β that have a larger range than the attribute α .

9. (Currently amended) A method as claimed in claim 8, characterized in that the calculation of the orthogonalized attribute function f_{α}^{ortho} for the attribute $\alpha=\beta_0$ comprises the following steps:

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- a) Selecting all the attributes β_i with $i=1\dots g$ in the speech model that have a larger range RW than the attribute $\alpha = \beta_0$ and include the latter;
- b) Calculating boundary values $f\beta_i$ for the attributes β_i with $i=0\dots g$;
- c) Sorting the attributes β_i with $i=0\dots g$ according to their RW;
- d) Selecting one of the attributes $[\beta_i]$ β_i having the largest RW;
- e) Checking whether there are other attributes β_k which include the attribute β_i and have a larger RW than the selected attribute β_i ;
- f1) If so, defining a function F as a linear combination of the orthogonalized attribute function $f_{\beta_k}^{ortho}$ calculated in step g) during the last run of the steps e) to g) for all the attributes β_k that have a larger range determined in the most recently run step e);
- f2) If not, defining the function F to F = 0;
- g) Calculating the orthogonalized attribute function $f_{\beta_i}^{ortho}$ for the attribute β_i by arithmetically combining the attribute function $f\beta_i$ with the function F; and
- h) Repeating the steps e) to g) for the attribute $[\beta_i]$ $\beta_i - 1$ whose range is smaller than or equal to the range of the attribute β_i until the orthogonalized attribute function $f_{\beta_0}^{ortho} = f_\alpha^{ortho}$ with $i=0$ has been calculated in step g).

10. (Original) A method as claimed in claim 9, characterized in that the calculation of the function F in step f1) is made according to the following formula:

$$F = \sum_k f_{\beta_k}^{ortho}$$

11. (Original) A method as claimed in claim 9, characterized in that the calculation of the orthogonalized attribute function $f_{\beta_i}^{ortho}$ in step g) is made according to the following formula:

$$f_{\beta_i}^{ortho} = f_{\beta_i} - F$$

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12. (Currently amended) A method as claimed in claim 1, characterized in that the mathematical function G has the following form:

$$\begin{aligned}\lambda_{\alpha}^{\text{ortho}(n+1)} &= G(\lambda_{\alpha}^{\text{ortho}(n)}, m_{\alpha}^{\text{ortho}}, \dots) \\ &= \lambda_{\alpha}^{\text{ortho}(n)} + t_{\alpha}^{\text{ortho}} \cdot \log \left(\frac{[t_{\alpha}^{\text{ortho}} \cdot m_{\alpha}^{\text{ortho}} + b_{\alpha}]}{[t_{\alpha}^{\text{ortho}} \cdot m_{\alpha}^{\text{ortho}(n)} + b_{\alpha}]} \cdot \frac{1 - \sum_{\gamma} [t_{\gamma}^{\text{ortho}} \cdot m_{\gamma}^{\text{ortho}(n)} + b_{\gamma}]}{1 - \sum_{\gamma} [t_{\gamma}^{\text{ortho}} \cdot m_{\gamma}^{\text{ortho}} + b_{\gamma}]} \right)\end{aligned}$$

where:

α : refers to a just considered attribute;

γ : refers to all the attributes in the speech model;

$t_{\alpha}^{\text{ortho}}$, $t_{\gamma}^{\text{ortho}}$: refer to the size of the convergence step with $t_{\alpha}^{\text{ortho}} = t_{\gamma}^{\text{ortho}} = 1/M^{\text{ortho}}$ with

$$M^{\text{ortho}} = \max_{(h,w)} \left(\sum_{\beta} f_{\beta}^{\text{ortho}}(h,w) \right);$$

where $[M^{\text{ortho}}]$ M^{ortho} for binary functions f_{β}^{ortho} represents the maximum number of functions which yield the value 1 for the same argument

(h,w);

$m_{\alpha}^{\text{ortho}}$, $m_{\gamma}^{\text{ortho}}$: refers to desired orthogonalized boundary values in the MESM for the attributes α and γ ;

$m_{\alpha}^{\text{ortho}(n)}$, $m_{\gamma}^{\text{ortho}(n)}$: refers to iterative approximate values for the desired boundary values $m_{\alpha}^{\text{ortho}}$, $m_{\gamma}^{\text{ortho}}$; and

b_{α} and b_{γ} : refer to constants.

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13. (Previously presented) A method as claimed in claim 1, characterized in that the mathematical function has the following form:

$$\begin{aligned}\lambda_{\alpha}^{\text{ortho}(n+1)} &= G(\lambda_{\alpha}^{\text{ortho}(n)}, m_{\alpha}^{\text{ortho}}, \dots) \\ &= \lambda_{\alpha}^{\text{ortho}(n)} + t_{\alpha}^{\text{ortho}} \cdot \log \left(\frac{m_{\alpha}^{\text{ortho}}}{m_{\alpha}^{\text{ortho}(n)}} \cdot \frac{1 - \sum_{\beta \in A_i(n)} (t_{\beta} \cdot m_{\beta}^{\text{ortho}(n)})}{1 - \sum_{\beta \in A_i(n)} (t_{\beta} \cdot m_{\beta}^{\text{ortho}})} \right)\end{aligned}$$

where:

n : represents the iteration parameter;

$A_{i(n)}$: represents an attribute group $A_{i(n)}$ with $1 \leq i \leq m$ selected in the n^{th} iteration step;

α : represents a just considered attribute from the just selected attribute group $A_{i(n)}$;

β : represents all the attributes of the attribute group $A_{i(n)}$;

$t_{\alpha}^{\text{ortho}}, t_{\beta}^{\text{ortho}}$: represents the size of a convergence step with $t_{\alpha}^{\text{ortho}} = t_{\beta}^{\text{ortho}} = 1/M_{i(n)}^{\text{ortho}}$
with

$$M_{i(n)}^{\text{ortho}} = \max_{(h,w)} \left(\sum_{\beta \in A_i(n)} f_{\beta}^{\text{ortho}}(h, w) \right)$$

where $M_{i(n)}^{\text{ortho}}$ represents for binary functions f_{β}^{ortho} the maximum number of functions from the attribute group $A_{i(n)}$ which yield the value 1 for the same argument (h,w) ;

$m_{\alpha}^{\text{ortho}}, m_{\beta}^{\text{ortho}}$: represent desired orthogonalized boundary values in the MESM for the attributes α and β respectively;

$m_{\alpha}^{\text{ortho}(n)}, m_{\beta}^{\text{ortho}(n)}$: represent iterative approximate values for the desired boundary values
 $m_{\alpha}^{\text{ortho}}, m_{\beta}^{\text{ortho}}$;

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where the selection of the group = $A_{i(n)}$ of attributes α , whose associated parameters λ_{α}^{ortho} are adapted to a current iteration step is made either cyclically or according to a predefined criterion.

14. (Currently amended) A speech recognition system [[(10)]] comprising: a recognition device [[(12)]] for recognizing the semantic content of an acoustic signal captured and rendered available by a microphone [[(20)]], more particularly a speech signal, by mapping parts of this signal onto predefined recognition symbols as they are offered by the implemented maximum-entropy speech model MESM, and for generating output signals which represent the recognized semantic content; and a training system [[(14)]] for adapting the MESM to recurrent statistical patterns in the speech of a certain user of the speech recognition system [[(10)]]; characterized in that the training system [[(14)]] calculates free parameters λ in the MESM in accordance with the method as claimed in claim 1.

15. (Currently amended) A training system [[(14)]] for adapting the maximum-entropy speech model MESM in a speech recognition system [[(10)]] to recurrent statistical patterns in the speech of a certain user of this speech recognition system [[(10)]], characterized in that the training system [[(14)]] calculates free parameters λ in the MESM in accordance with the method as claimed in claim 1.